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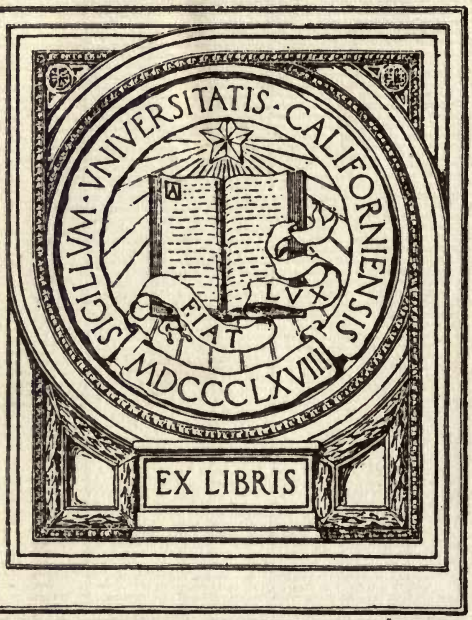
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New York State Museum

JOHN M. CLARKE, Director
EPHRAIM PORTER FELT, State Entomologist

Museum

Bulletin 109

ENTOMOLOGY 27

109-110
1907.

WHITE MARKED TUSSOCK MOTH AND ELM LEAF BEETLE

BY

EPHRAIM PORTER FELT D. Sc.

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New York State Education Department
Science Division, October 31, 1906

Hon. Andrew S. Draper LL. D.
Commissioner of Education

MY DEAR SIR: I communicate herewith for publication as a bulletin of the State Museum a paper of immediate importance by the State Entomologist, entitled the *White Marked Tussock Moth and Elm Leaf Beetle.*

Very respectfully yours
JOHN M. CLARKE
Director

State of New York
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Approved for publication, November 3, 1906

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New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

EPHRAIM PORTER FELT, State Entomologist

Bulletin 109

ENTOMOLOGY 27

WHITE MARKED TUSSOCK MOTH AND ELM LEAF BEETLE

BY

EPHRAIM PORTER FELT D. Sc.

These two insects must be ranked among the most important leaf feeders affecting the shade trees of cities and villages in New York State. They were responsible during the season of 1906 for widespread injury to thousands of trees, and the experience of earlier years shows that we must reckon with these species if we would preserve the beauty of our trees. Both of these pests, despite their destructiveness, are controlled with relative ease. The tussock moth can be readily suppressed in at least two ways, while the elm leaf beetle succumbs quickly to timely applications of arsenical poisons. Experience in the past has demonstrated beyond all question the practicability of checking both of these leaf feeders by spraying, an operation which is not very costly if modern apparatus be employed. We are forced to conclude therefore that extensive injury by either of these pests must be attributed to indifference or culpable neglect rather than inability, despite the fact that many appear very eager to take up the warfare at a time when the ravages are most apparent and unfortunately when repressive measures can be employed to very little advantage.

There is a tendency on the part of many private individuals to attribute their woes to the neglect of adjacent shade trees on public

streets, and conversely municipal authorities are prone to state that injury to public trees is due to the pests swarming thereto from neglected private grounds. The facts of the case are that both of these insects are very local in habit. This is a necessity in the case of the tussock moth, because the female is wingless and as a consequence the species relies for dissemination on the very limited crawling powers of the caterpillar or upon their being carried by other agencies. The elm leaf beetle, on the contrary, flies readily, but for some reason or other it is very local in its habits and not infrequently one may see magnificent trees infested with hordes of beetles and larvae, while within a block, sometimes within 50 feet, other elms may be practically free from the pest. These facts are of greatest importance to all interested in the welfare of shade trees, since they demonstrate beyond question the possibility of protecting the trees on our public streets, irrespective of what is done by private citizens, or conversely, the practicability of keeping the pest in check on private grounds, even though little or no repressive work is done upon those adjacent.

White marked tussock moth

Hemerocampa leucostigma Abb. & Sm.

This insect, preeminently a pest on city and village trees, occasionally proves a veritable scourge over considerable areas. Some cities appear to be more afflicted in this way than others. Buffalo seems to have been specially unfortunate in the last six or seven years. The summer of 1906 was marked by extensive depredations in a number of cities and villages throughout the State, thus duplicating the experience of 1898. It will therefore be seen that serious injuries by this caterpillar are more or less periodic. This is to be explained by the fact that the species has a number of natural enemies which assist materially in keeping it in subjection. The destructive outbreaks are examples of what might occur annually were there no parasites to check the work of this voracious leaf feeder. The cause of this native species thriving so greatly in cities and villages during recent years is explained by the abundance of the English sparrow. This bird will not eat the caterpillars and drives away many of the native forms which, in earlier days, were of great service in devouring these hairy pests.

Description. The full grown caterpillar is really a beautiful object. It has a coral red head, a pair of long, black plumes just over it, a single one at the opposite extremity of the body, four delicate yellowish or white, brushlike tufts on its back and just behind them, separated only by a segment, two small retractile red elevations. There is a broad, black band broken only by tubercles and tufts along the back and bordered by yellowish stripes. Each side is dark gray except for the yellowish tubercles. The breathing tubes or spiracles are in a black line and below this the caterpillar is yellow, the legs usually being paler [pl. 1, fig. 4]. The very young caterpillar is pale yellowish or whitish with long, irregular hairs. It increases in size, casts its skin from time to time and assumes one after another the characteristics of the full grown larva.

The thin cocoons spun in the crevices of the bark [pl. 1, fig. 6] have the long hairs of the caterpillar interwoven and within this shelter the larva transforms to a yellowish white pupa more or less shaded with dark brown or black [pl. 1, fig. 7].

The sexes differ strikingly as is shown on plate 1, figures 1 and 2. The male is a beautiful moth with large feathery antennae, tufted legs, and with the wings and body delicately marked with several shades of gray or grayish white. The female, on the other hand, is a nearly uniform gray with simple antennae and but rudimentary wings.

The eggs, usually over 300, are deposited on the empty cocoon, under a conspicuous white mass of frothy matter about ½ inch in diameter [pl. 1, fig. 3]. This soon hardens and forms a very effective protection. The egg masses [pl. 4, 5] are easily removed and a tree thoroughly cleared thereof can become infested again only by caterpillars crawling from adjacent trees or being carried thereto. The individual egg is nearly spheric, about 1/25 inch in diameter, white or yellowish white and with a light brown spot surrounded by a ring of the same color.

Life history and habits. This insect winters in the conspicuous egg masses described above, the young appearing about the latter part of May in this latitude. They feed at first on the more tender lower epidermis of the leaf and soon devour all but the principal veins. The caterpillars while young frequently hang by a silken thread and continued jarring may cause many to drop to the ground. Feeding and growth occupy a month or more, pupation occurring

the latter part of June or early in July. There is some deviation from this, as a few individuals spin up early and some caterpillars linger till numerous egg clusters indicate that most of the insects have completed the round of life. The pupal stage occupies from 10 to 15 days. The wingless female appears at the end of this period, crawls on her cocoon and shortly deposits eggs as described. There is normally but one annual generation in Albany and other inland cities, while in New York city and vicinity and in Boston, Mass. there are two broods and at Washington, D. C. there are three generations each year as stated by Dr Howard.

A peculiar habit, first recorded by the late Dr Lintner and subsequently observed by us, is the girdling of the elm twigs by larvae of this insect. This is caused by their eating a portion of the bark around the twig near the beginning of the season's growth [pl. 1, fig. 8]. The affected tips soon die, break off and fall in numbers to the ground. The young caterpillars drop from the tree readily, suspend themselves by silken threads and then may be blown or carried considerable distances. The full grown caterpillars desert the trees and wander considerably. This is particularly true of the larger ones which almost invariably produce female moths. The cocoons are spun very generally on the trunks or on the underside of the larger branches.

Food plants. This leaf feeder exhibits a marked preference in cities for the linden and horse-chestnut, while it feeds readily on elms and maples. It has also been recorded on a number of other trees.

Natural enemies. This species has a number of natural enemies. Its comparative rarity in the country shows that our native birds must be very efficient natural checks upon this insect. Mr E. H. Forbush states that 47 species of native birds feed on hairy caterpillars, most of which would probably take this leaf feeder. The robin, Baltimore oriole and cuckoo are among the more valuable in this respect.

Parasitic insects are also very efficient checks. This species is subject to attack by some 21 primary parasites and these in turn may become the prey of 14 hyperparasites.

Remedies. A simple and very satisfactory method of controlling this insect is the gathering and destroying of egg masses. Several cities and villages in New York State have employed children in this

work by offering a small bounty and a system of prizes. The result has been that a large number of egg masses were secured and destroyed at a comparatively slight cost. The defect in this method is that it is more or less irregular in operation and is usually resorted to only after serious injury to the trees has aroused public opinion. There is no doubt as to the effectiveness of collecting egg masses and in not a few instances it may prove the cheapest method of keeping this pest in check. It would seem better for the welfare of the trees to make some provision for the systematic collection of egg masses from year to year from all the trees, even though the cost be somewhat greater.

The collection of egg masses should be supplemented, if uncleaned trees are in the vicinity, by banding the trunks at the time the caterpillars begin to crawl, with some material which will prevent the ascent of straggling larvae. A very simple method is to take a band of cotton batting some 6 or 8 inches wide, wrap it around the tree, tie a string about its middle and then turn the upper edge down over the string. Tree tanglefoot, a preparation made by the same company that manufactures tanglefoot fly paper, has been used very extensively on trees about Boston. It is very adhesive, remains sticky for a considerable time and does not injure the bark of older trees at least.

The tussock moth caterpillar succumbs readily to arsenical poisons and where the trees are infested or are likely to be attacked by more than one leaf feeder, as is true in the Hudson valley, spraying is perhaps the best method of protecting the trees. One of the best poisons for this purpose, particularly in sections infested by the elm leaf beetle, is the prepared arsenate of lead, a compound specially manufactured for this purpose. It can be applied in almost any quantities without injuring the trees and is far more adhesive than the commonly employed london purple, paris green or other copper arsenites.

Elm leaf beetle

Galerucella luteola Müll.

This destructive beetle, like the white marked tussock moth discussed previously, is a most dangerous enemy to certain shade trees, particularly in cities. It is in all probability responsible for more ruined elms in the Hudson valley than all other destructive agencies combined. It was so exceedingly abundant and injurious from 1896

to 1899 in the cities of Albany and Troy as to literally compel some action, or a very large proportion of the elms would have been destroyed. The insect obtained such a start in both of these cities that it was able to destroy or ruin about 1500 elms in each before the end of 1900. The vigorous measures employed both in Albany and Troy have mitigated the plague very largely and have demonstrated the practicability of keeping the insect in check. The results in both cities are evident to any observer, because instead of a large proportion of the elms having their leaves skeletonized and browned in midsummer, as was the rule in 1896 to 1898, the work of this pest is observed only here and there and is limited to sections where the trees have not been thoroughly sprayed or to localities where neglect is the rule. This was very well shown in the summer of 1906 in both Albany and Troy. The effective work of earlier years had led many to suppose that the elm leaf beetle was becoming less injurious and consequently there was a decided relaxation in the efforts to control this insect. A very large number of trees in both cities suffered severely as a result of this partial cessation in control work.

Food plants. This leaf feeder displays a marked preference for the more tender foliage of the English and Scotch elms, though after it has become abundant, it is frequently exceedingly destructive to the American elm. Its operations on this latter tree have been especially severe in the city of Watervliet.

Distribution. This pest has now attained an extensive distribution in this country, ranging from north of Salem, Mass. to Charlotte, N. C. and westward into Ohio and Kentucky. It occurs in most of the cities and villages in the Hudson valley, having made its way north to Glens Falls and along the Mohawk valley at least to Schenectady. It has become well established at Elmira and Ithaca, N. Y., and has been known for some years in Oswego, though it does not appear to have been particularly destructive in that city. There is no record known to us of this species occurring in Utica, Syracuse, Rochester or Buffalo, though it is rather surprising that it has not already become established in all of these cities.

Description. The skeletonized brown appearance of the foliage in midsummer is very characteristic of the work of this pest, particularly in the eastern cities and villages of the State. The irregular, oval holes about ¼ inch in diameter, eaten by the beetles in early spring, are another indication of the work of this species.

The parent beetle may be recognized by reference to the colored illustration [pl. 2, fig. 5, 6]. It is about ¼ inch long, with the head, thorax and margin of the wing covers a reddish yellow. The coal-black eyes and median spot of the same color on the head are prominent. The thorax is marked with a dorsal black spot of variable shape and with a pair of lateral ovoid ones. The median black line on the wing covers is widely separated from lateral stripes of the same color by greenish yellow. The wing covers are minutely and irregularly punctured, bear a fine pubescence and at the base of each there is an elongated, black spot in the middle of the greenish yellow stripe. These markings are fairly constant in the beetle, though the color is quite variable during life and changes more or less after death. Many of the insects emerging from winter quarters have the yellowish stripes of the wing covers nearly obliterated by black.

The orange-yellow eggs [pl. 2, fig. 1] are usually deposited in irregular rows side by side, forming clusters of from 3 to 26 or more on the underside of the leaf. Each egg is somewhat fusiform, attached vertically by its larger end and with the free extremity tapering to a paler rounded point.

The recently hatched grub [pl. 2, fig. 2] is about 1/20 inch long with the head, thoracic shield, numerous tubercles, hairs and legs jet-black. The skin is dark yellow but the tubercles are so large and the hairs so prominent that the prevailing color of the grub at this stage is nearly black. An increase in size, following molts, is accompanied by the stiff hairs becoming less conspicuous and the yellow more prominent, till the grub becomes full grown [pl. 2, fig. 3]. It is then about ½ inch long, more flattened than in the earlier stages, with a broad, yellowish stripe down the middle of the back and with a narrower stripe of the same color on each side, these being separated by broad, dark bands thickly set with tubercles bearing short, dark colored hairs. The dorsal yellow stripe is broken on each side by a subdorsal row of black tubercles which decrease in size posteriorly. The lateral yellow stripe includes a row of prominent tubercles with dark tips bearing hairs of the same color. The under surface is yellowish.

The pupa [pl. 2, fig. 4] is a bright orange-yellow, about ⅕ inch long and with a very convex dorsal surface which bears transverse rows of stout, inconspicuous hairs.

Life history. The transformations of this insect are so rapid and so greatly influenced by local conditions that a man must know what to expect or he will accomplish very little in fighting the pest, because a substance effective against the beetles or grubs may not kill the pupae and, after the larvae have begun to descend, may be of no value. The beetles winter in attics, sheds, outhouses and other shelters. They emerge with the advent of warm weather and may then be found on the walks during the sunny portion of the day or at the windows of houses, trying to escape. The last of April or early in May, with the appearance of the foliage, the beetles fly to the elms and eat irregular holes in the leaves. Some time is occupied in feeding before the deposition of eggs, a process which may continue four and possibly five or six weeks. The prolific beetles consume a large amount of foliage during this time, depositing clusters of from 3 to 26 or more eggs every day or two. Over half the total number of eggs may be laid at the hight of the season within about 12 days; in 1898, from June 12 to 23. A female may produce over 600 eggs.

The young grubs appear early in June or about five or six days after the eggs have been deposited later in the season. They feed on the under surface of the leaf, producing the familiar skeletonization [pl. 2, fig. 7] which is caused by their eating the softer underpart, leaving the veins and the upper epidermis practically untouched. The results of their feeding are so marked that it is easy to detect the presence of the grubs by the semitransparent patches in the foliage. These latter soon dry and turn brown.

There are two and occasionally three generations of this destructive insect in the latitude of Albany, the number depending to a considerable extent upon the availability of suitable food. The grubs complete their growth in from 15 to 20 days, descending limbs and trunk to a great extent in search of some shelter under which to pupate. Seven days are spent in this latter state in warm July weather, while in September it is extended to 12 and in October to 24 days. The grubs of the first brood usually forsake the trees in Albany by the last of June or early in July, and beetles belonging to the second generation may begin depositing eggs about the middle of July, and from then to late in autumn it is generally possible to find this insect in all stages in some part of Albany. The beetles of the second brood are naturally attracted to fresh foliage and conse-

quently more eggs are usually deposited on trees which have been defoliated earlier in the season than upon others.

Badly infested trees are therefore very likely to lose two crops of leaves in a season and may possibly have their third seriously marred by this pest. The second brood of grubs completes its growth about the middle of August, beetles appearing the latter part of the month, and if there is an abundant supply of fresh leaves, a third generation may appear in considerable numbers. This last brood more frequently occurs in near-by trees which have not been severely injured earlier in the season.

Natural enemies. This leaf feeder is subject to attack by a number of natural enemies, most of which, however, are of comparatively little importance in keeping it in check. The common garden toad will devour many beetles, and the much despised English sparrow also feeds upon these insects to some extent. Several predaceous insects prey upon this pest to a certain degree.

Remedial measures. The secret in controlling this insect lies in understanding thoroughly its life history and appreciating the vulnerable points. A thorough spraying with an arsenical poison early in the spring, when the beetles begin to feed, is most effective in preventing breeding, as the parent insects are destroyed before they can deposit many eggs. Fortunately the beetles are rather local in habit and as a consequence individual trees or groups of trees may be protected to a very large extent even if there are neglected ones in the near vicinity. The local spread of this pest is slow and this should be taken advantage of to the greatest possible extent by keeping the insect in control wherever it occurs, even though the infestation be a small one and the present injury of comparatively little importance. It is a mistake on the part of local authorities to wait till this enemy of the elms has become well established and destructive before repressive measures are undertaken.

The grubs feed almost exclusively on the under surface of the leaf, rarely occurring upon its upper side. The first injury is usually on the upper more tender leaves, hence there is great need of spraying the tops of the trees, and in order to kill the destructive grubs it is essential that the poison be thrown on the underside of the foliage. Spraying with an arsenical poison for the destruction of grubs is satisfactory only when the application is early, as it is hardly advisable to spray for this insect when the grubs are nearly full grown,

since they are liable to desert the tree even when slightly underfed and complete their transformations, rather than to eat distasteful foliage.

The full grown larvae crawl down the trunks in great numbers and the golden yellow pupae may be found in abundance in crevices in the bark and on the ground about the tree. A great proportion of the insects can be forced to take refuge on the ground by scraping off the rough bark, thus depriving them of shelters upon the tree. Large numbers can then be killed when assembled about the base of the tree by spraying them with a contact insecticide such as kerosene emulsion, whale oil soap solution or even by pouring boiling water on them. The grubs should be destroyed in the manner indicated every five days so long as the pests are seen in numbers, in order to secure the best results. This method of fighting the pest is advisable only when it is impossible to employ the more satisfactory arsenical sprays. Bands of tar, sticky fly paper, cotton batting etc., while they do no harm, can not be considered of much value in keeping the elm leaf beetle under control. The relatively few grubs caught on a sticky band are but a drop in the bucket compared with the masses which complete their transformations either above or below. It is worse than useless to attempt to control this or any other insect by boring a hole in the trunk of a tree and inserting therein compounds of any nature. The tree is weakened and unless the chemical be powerful enough to kill it, the insects are not affected.

EXPLANATION OF PLATES

PLATE I[1]

1 Executed from nature by L. H. Joutel.

White marked tussock moth

Hemerocampa leucostigma Abb. & Sm.

1 Male moth at rest on trunk
2 Female laying eggs upon her cocoon
3 Egg masses on cocoons
4 A full grown caterpillar resting on a twig
5 Cast skins of caterpillars
6 Cocoons massed on trunk
7 Pupa of female within cocoon
8 Twigs girdled by caterpillars
8*a* Twig broken off at point of girdling

The foliage shows the effects of this caterpillar's work.

L. H. Joutel, 1906

James B. Lyon, State Printer

WHITE MARKED TUSSOCK MOTH

PLATE 21

1 Executed from nature, under the author's direction, by L. H. Joutel of New York city, and reproduced from the 5th Report of the Commissioners of Fisheries, Game and Forests through the courtesy of the commissioners.

Elm leaf beetle

Galerucella luteola Müll.

1 Cluster of eggs, much enlarged

1*a* Side view of single egg, still more enlarged

2 Recently hatched larva or grub, much enlarged

3 Full grown larva or grub, much enlarged

4 Pupa, much enlarged

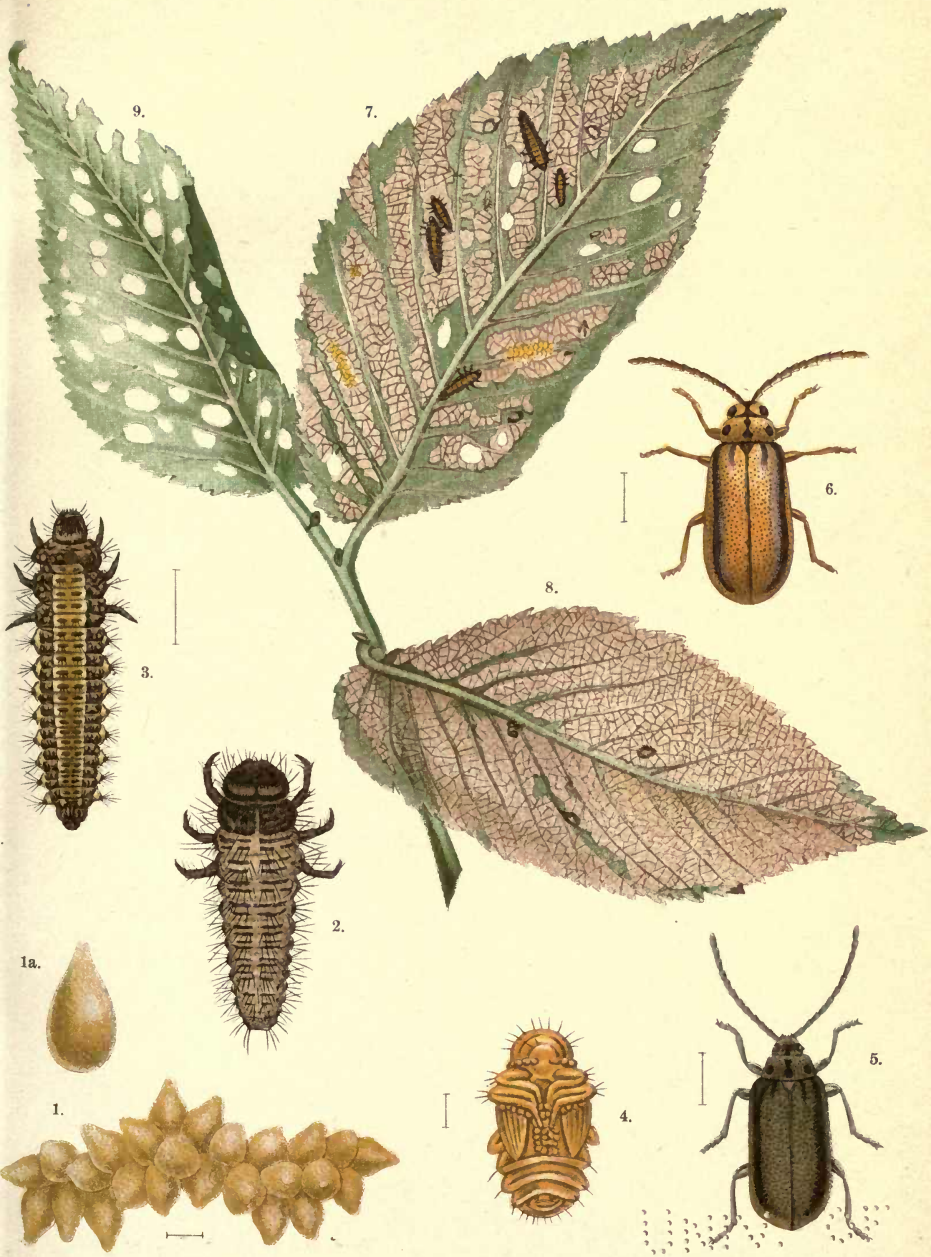
5 Overwintered beetle, much enlarged

6 Fresh, brightly colored beetle, much enlarged

7 Leaf showing eating of larvae or grubs and a few holes eaten by beetles, eggs in clusters, cast larval skins and full grown larvae, natural size

8 Leaf skeletonized by grubs

9 Leaf eaten by beetles



. H. Joutel, 1900

ELM LEAF BEETLE

James B. Lyon, State Printer.

(Reprint from 5th report of commissioners of fisheries, game and forests.)

PLATE 3

Work of white marked tussock moth, H e m e r o c a m p a l e u c o-s t i g m a Abb. & Sm., on clump of horse-chestnuts standing on the grounds of St Francis de Sales Asylum, Albany. Photo August 1906

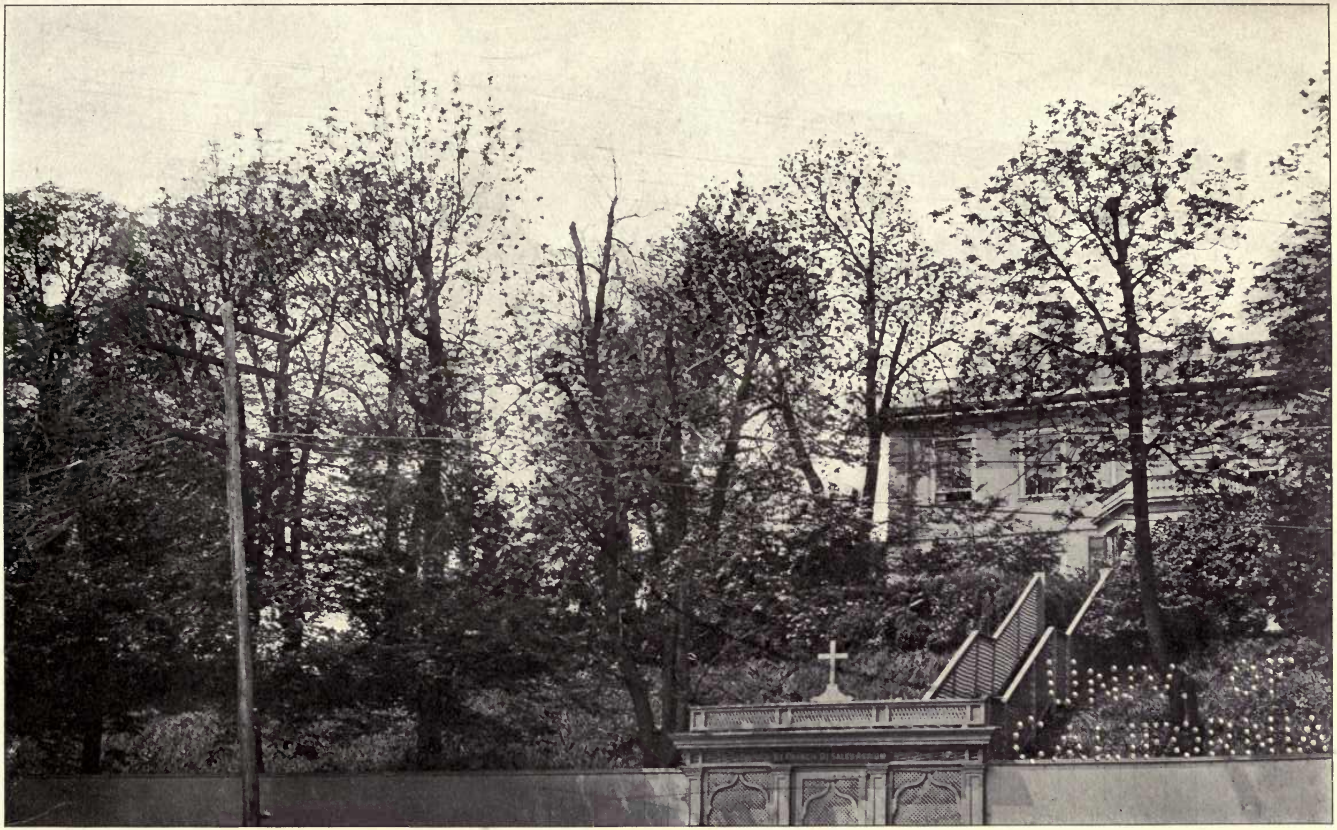


PLATE 4

Egg masses of white marked tussock moth, Hemerocampa leucostigma Abb. & Sm., on American elm. Congress street, Albany, photo August 1906. Note that the egg masses are conspicuous, attached to slight cocoons and therefore easily removed.

Albany, Aug. 1906

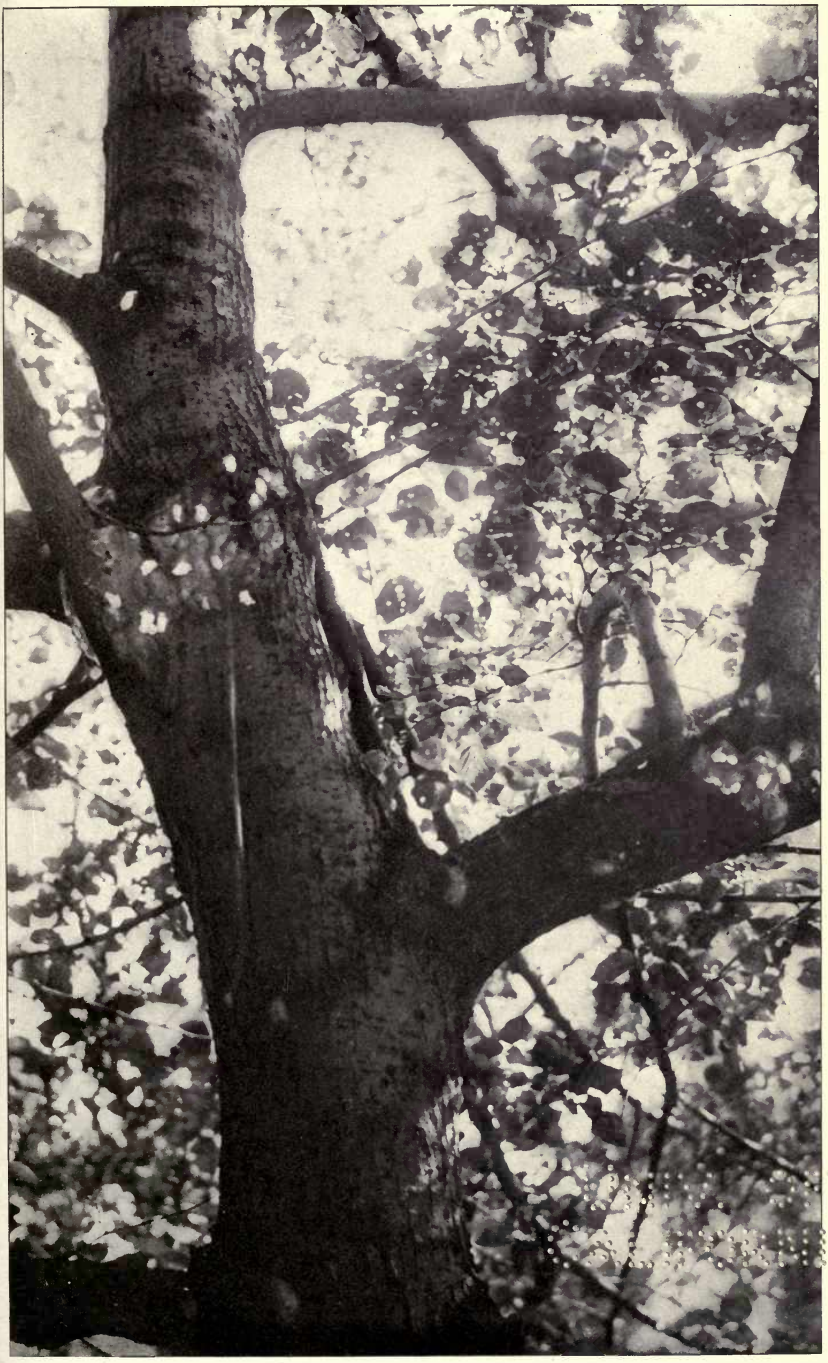
White marked tussock moth eggs on Spring street

[illegible]

PLATE 5

23

Egg masses of white marked tussock moth, Hemerocampa leucostigma Abb. & Sm., on English elm. Capitol park, Albany, photo August 1906. Note that the egg masses are conspicuous, attached to slight cocoons and therefore easily removed.



Capitol park, Albany, Aug. 1906

White marked tussock moth eggs

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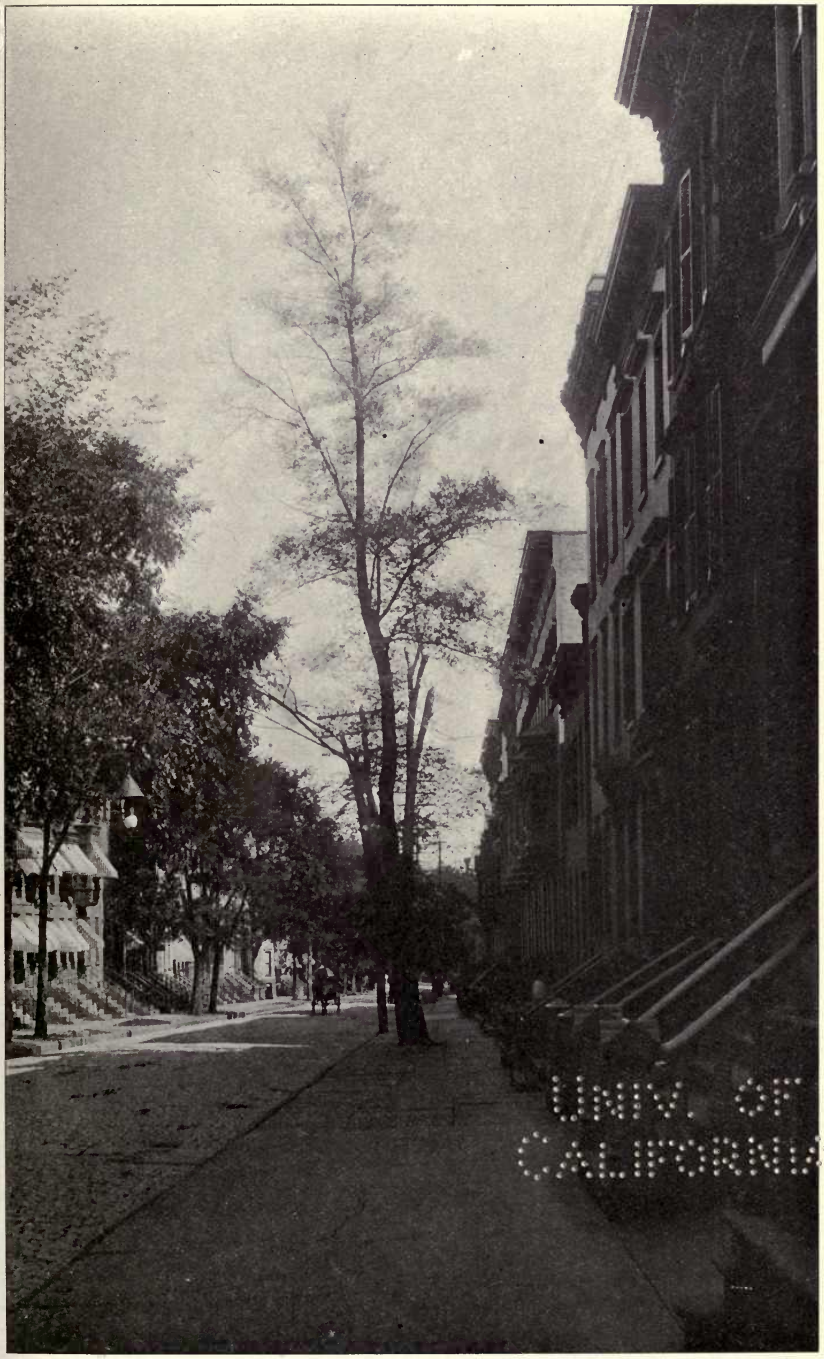
PLATE 6

25

A magnificent English elm nearly defoliated by the elm leaf beetle, Galerucella luteola Müll. Lancaster street, Albany, photo August 1906



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Albany, Aug. 1906

Work of elm leaf beetle on Lancaster street

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PLATE 7

27

Row of English elms on South Hawk street, Albany, nearly ruined by the work of the elm leaf beetle, Galerucella luteola Müll. Photo August 1906. These nine trees were, in 1898, in about the same condition as the one illustrated on plate 6.

Plate 7

Albany, Aug. 1906

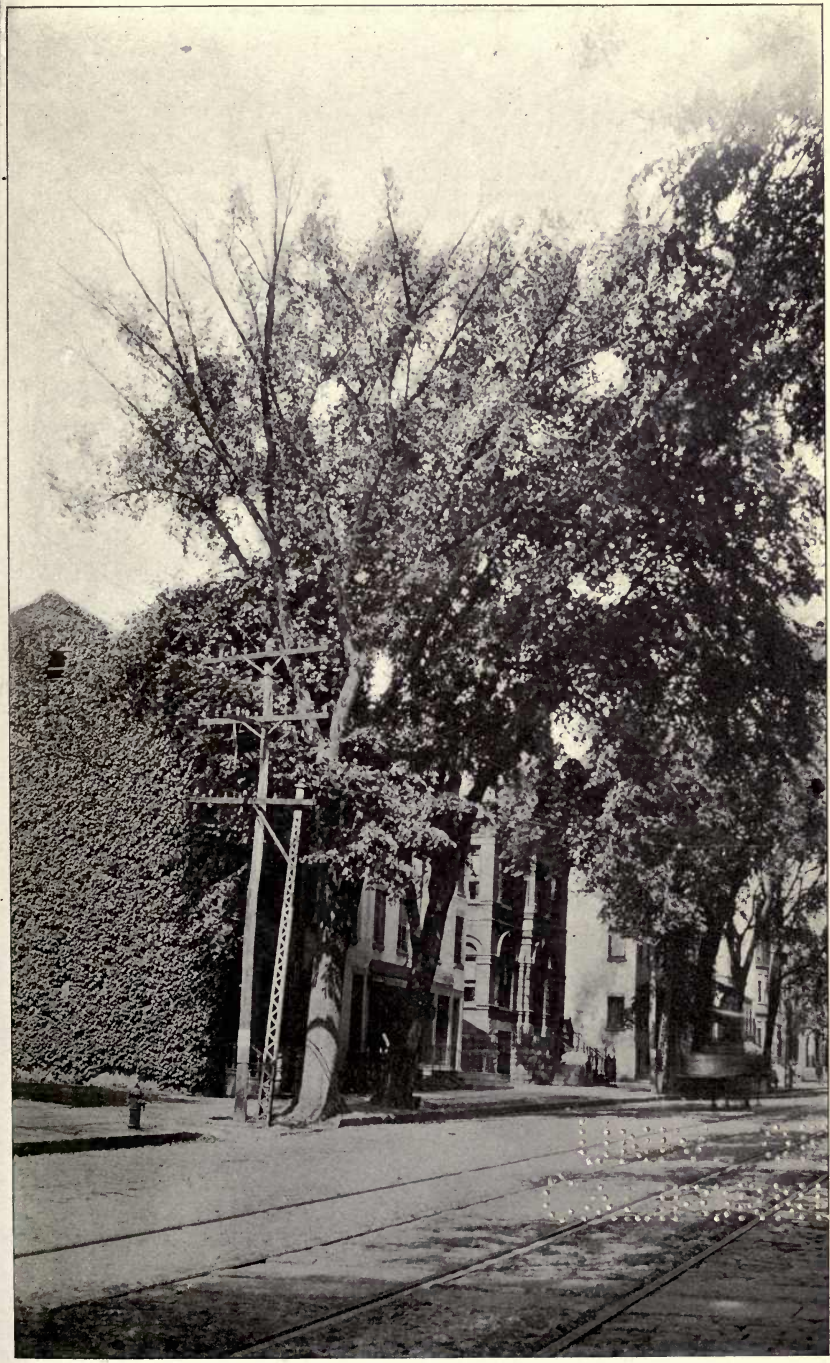
Work of elm leaf beetle on South Hawk street

DO NOT
REMOVE

PLATE 8

29

American elm on Washington avenue near Fort Orange Club, Albany, seriously injured by the elm leaf beetle, Galerucella luteola Müll., photo August 1906. Note the numerous dead limbs.



Albany, Aug. 1906

Work of elm leaf beetle on Washington avenue

CONTAGION
PLATE 01

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New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

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Museum annual reports 1847–date. *All in print to 1892, 50c a volume, 75c in cloth; 1892–date, 75c, cloth.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Report for 1904. 138p. *20c.* Report for 1905. 102p. 23pl. *30c.*

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, O; 2, 14–16, Q.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 30th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	9	$.25	15 (En 9)	$.15
2	.30	10	.35	16 (" 10)	.25
5	.25	11	.25	17 (" 14)	.30
6	.15	12	.25	18 (" 17)	.20
7	.20	13	.10	19 (" 21)	.15
8	.25	14 (En 5)	.20	20 (" 24)	.40
				21 (" 26)	.25

Reports 2, 8–12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–96 and 1898 (Botany 3) are out of print. Report for 1897 may be had for 40c; 1899 for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins [*see* Bo 5–9].

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903) and 58th (1904) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887-date. O. *To advance subscribers, $2 a year or $1 a year for division* (1) *geology, economic geology, paleontology, mineralogy; 50c each for divisions* (2) *general zoology, archeology and miscellaneous,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
G 1	48, v.1	Pa 2, 3	54, v.3	En 11	54, v.3	Ar 3	52, v.1
2	51, v.1	4	" v.4	12, 13	" v.4	4	54, v.1
3	52, v.1	5, 6	55, v.1	14	55, v.1	5	" v.3
4	54, v.4	7–9	56, v.2	15–18	56, v.3	6	55, v.1
5	56, v.1	10	57, v.1	19	57, v.1, pt 2	7	56, v.4
6	57, v.1	Z 3	53, v.1	20	" v.1 "	8	57, v.2
Eg 5, 6	48, v.1	4	54, v.1	21	" v.1 "	9	" v.2
7	50, v.1	5–7	" v.3	22	" v.1 "	Ms 1, 2	56, v.4
8	53, v.1	8	55, v.1	Bo 3	52, v.1		
9	54, v.2	9	56, v.3	4	53, v.1	*Memoir*	
10	" v.3	10	57, v.1	5	55, v.1	2	49, v.3
11	56, v.1	En 3	48, v.1	6	56, v.4	3, 4	53, v.2
M 2	" v.1	4–6	52, v.1	7	57, v.2	5, 6	57, v.3
3	57, v.1	7–9	53, v.1	Ar 1	50, v.1	7	" v.4
Pa 1	54, v.1	10	54, v.2	2	51, v.1		

The figures in parenthesis in the following list indicate the bulletin's number as a New York State Museum bulletin.

Geology. G1 (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. *10c.*

G2 (19) Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [*50c*]

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. *5c.*

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. *25c.*

G5 (56) Merrill, F. J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. *10c.*

G6 (77) Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. *30c.*

G7 (83) Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. 62p. 25pl. map. June 1905. *25c.*

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Woodworth, J. B.; Hartnagel, C. A.; Whitlock, H. P.; Hudson, G. H.; Clarke, J. M.; White, David; Berkey, C. P. Geological Papers. *In press.*

Contents: Woodworth, J. B. Postglacial Faults of Eastern New York.
Hartnagel, C. A. Stratigraphic Relations of the Oneida Conglomerate.
—— Upper Siluric and Lower Devonic Formations of the Skunnemunk Mountain Region.
Whitlock, H. P. Minerals from Lyon Mountain, Clinton Co.
Hudson, G. H. On Some Pelmatozoa from the Chazy Limestone of New York.
Clarke, J. M. Some New Devonic Fossils.
—— An Interesting Style of Sand-filled Vein.
—— Eurypterus Shales of the Shawangunk Mountains in Eastern New York.
White, David. A Remarkable Fossil Tree Trunk from the Middle Devonic of New York.
Berkey, C. P. Structural and Stratigraphic Features of the Basal Gneisses of the Highlands.

Fairchild, H. L. Drumlins of New York. *In press.*

——Later Glacial Waters in Central New York. *Prepared.*

Cushing, H. P. Geology of the Theresa Quadrangle. *In preparation.*

—— Geology of the Long Lake Quadrangle. *In press.*

Berkey, C. P. Geology of the Highlands of the Hudson. *In preparation.*

Economic geology. Eg1 (3) Smock, J. C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 (7) —— First Report on the Iron Mines and Iron Ore Districts in the State of New York. 6+70p. map. June 1889. *Out of print.*

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2 Hall, James & Clarke, J. M. Paleozoic Reticulate Sponges. 350p. il. 70pl. 1898. *$1, cloth.*

3 Clarke, J. M. The Oriskany Fauna of Becraft Mountain, Columbia Co. N. Y. 128p. 9pl. Oct. 1900. *80c.*

4 Peck, C. H. N. Y. Edible Fungi, 1895–99. 106p. 25pl. Nov. 1900. *75c.*
This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the State Botanist.

5 Clarke, J. M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. *$1.50, cloth.*

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7 Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the Lower Beds. 350p. 17pl. Feb. 1905. *$1.50, cloth.*

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